Measurement of Direct Photons in $\sqrt{s}$=200GeV p+p collisions

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For the PHENIX collaboration
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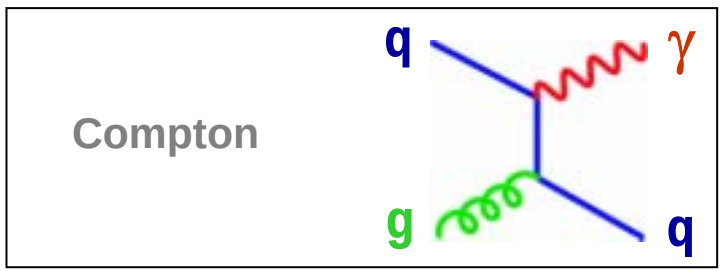
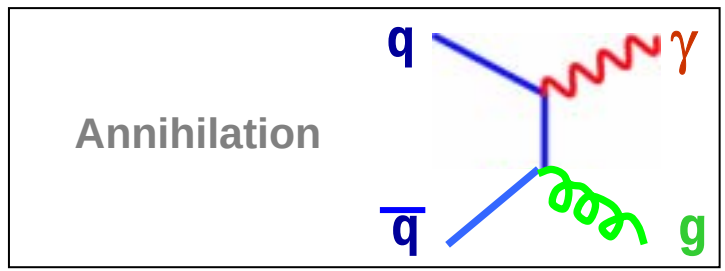
Motivations

—Test of our theoretical understanding based on QCD
—Direct information on gluon distribution in the proton
With polarized beam at RHIC, it is a probe for gluon polarization
—Reference for A+A collisions



80~90%

Dominant



20~10%

Data

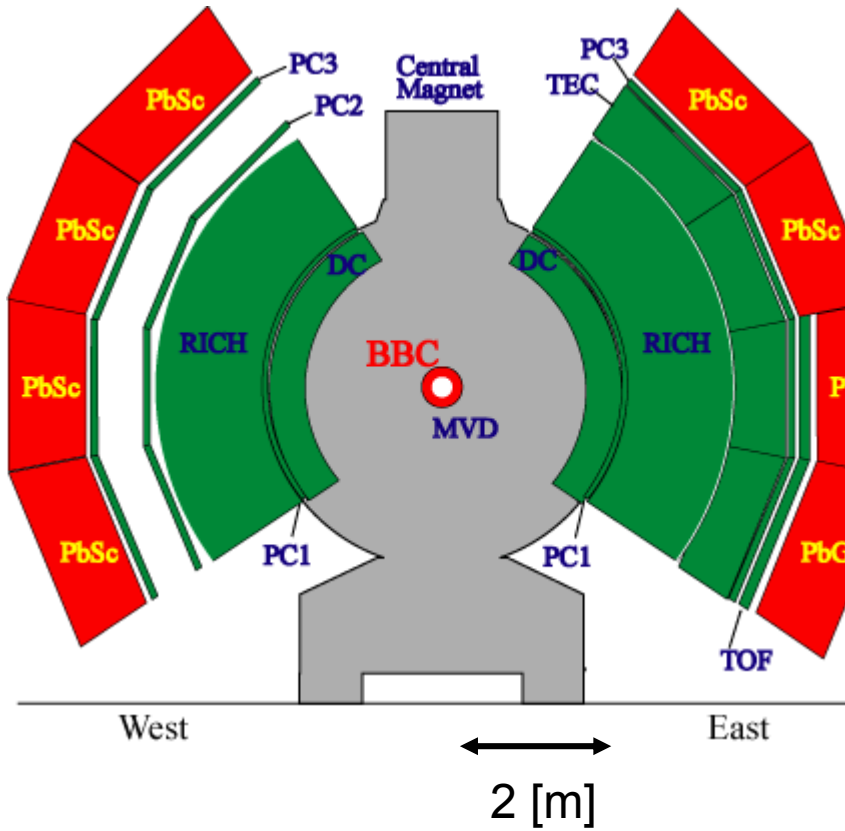
RHIC run3 p+p

2003 April-May
√s=200GeV Proton-proton collisions
Luminosity= 240nb^{-1}

RHIC-PHENIX detector

Central Arm (West)
(Rapidity |y|<0.35)
Electromagnetic Calorimeter (EMCal)
Photon detection
High granularity (~10*10mrad^2)
Drift chamber (DC)
Charged hadron veto
Beam forward / backward
(Rapidity 3.1<|y|<3.9)
Beam-beam counter (BBC)
Triggering and vertex determination
Luminosity measurement

BBC and EMCal Trigger for the data taking



Analysis Strategy

Photon cluster selection

—Photon shape cut (important to remove merged π^0 clusters)
—Charged veto with DC track
—Timing cut

π^0 photon tag

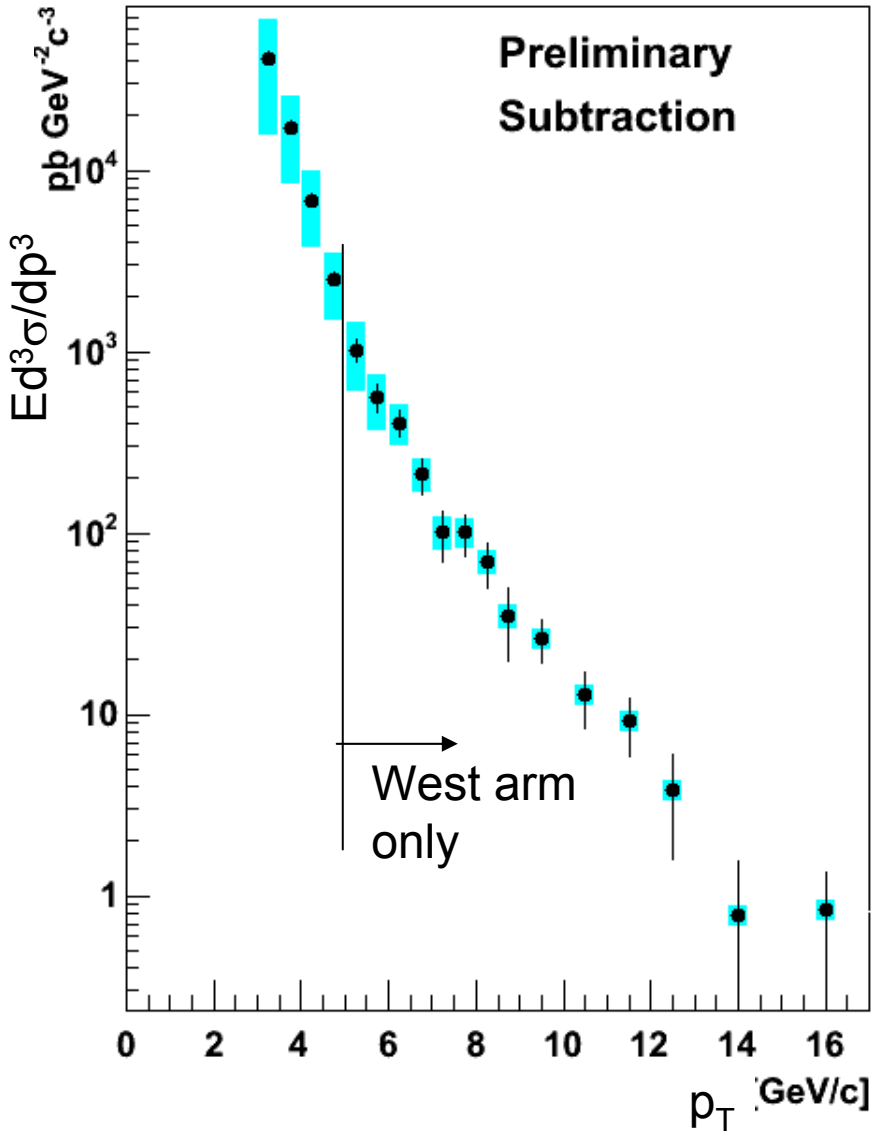
—Count photons with π^0 partner
—Estimate π^0 photons without partner
(it is only kinematics and geometrical issue)

Other hadron to photon estimation (η,ω, etc.)

—Scale π^0 photon contribution by their production and branching ratio

The rest is our direct photon signal !! **(Subtraction method)**

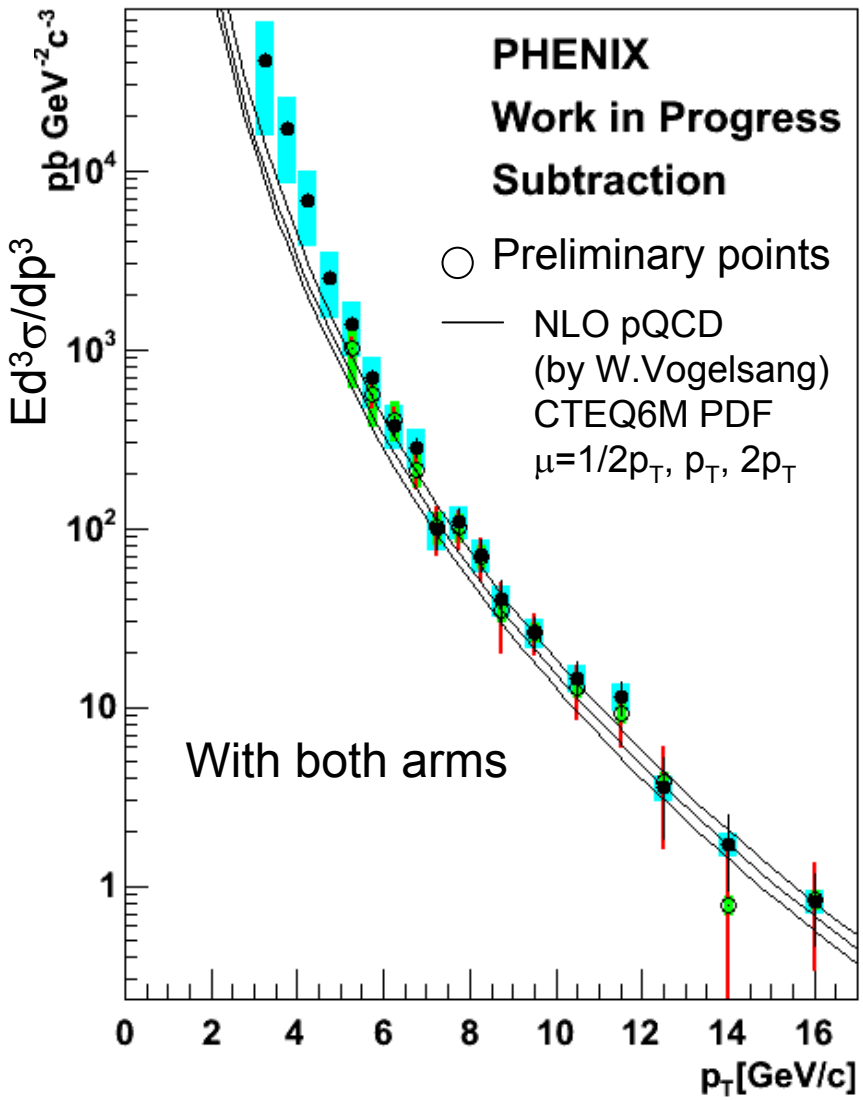
Subtraction method

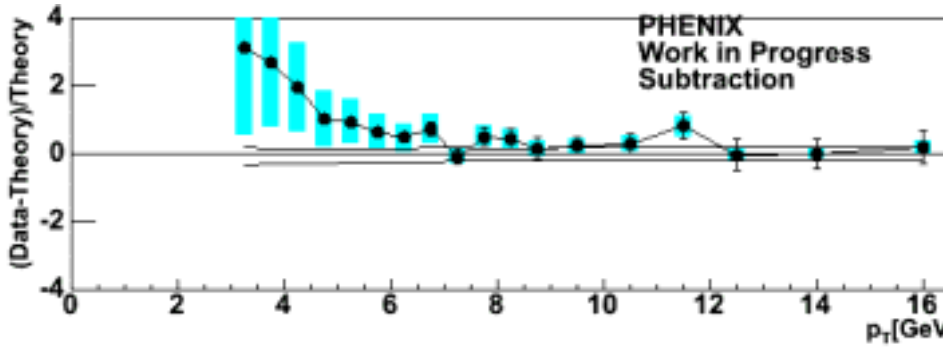


Systematic error sources ✓ ✓ ✓ ✓

	pT region Low	Mid	High
Luminosity	✓	✓	✓
Energy scale	✓	✓	✓
Non photon BG	✓		
Pi0 tag	✓	✓	
Missing π^0	✓	✓	
Non π^0 photon	✓	✓	

Subtraction method





NLO pQCD calculation explains the data well.

At low pT, the data show an excess.

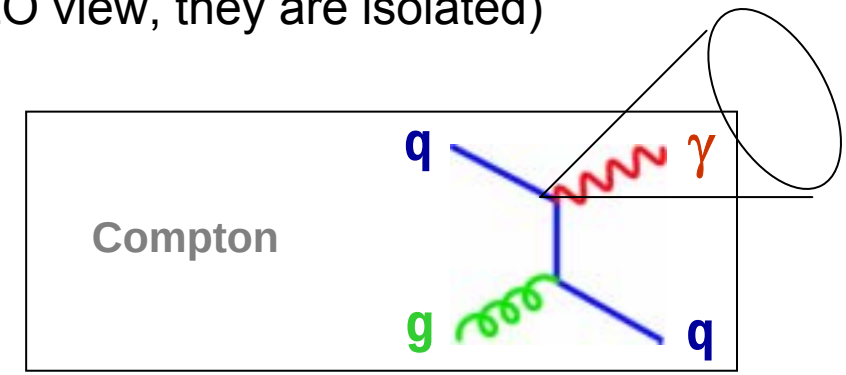
—with large systematic error

—but may be soft physics contribution as well

Isolation cut method : 2 goals

1

— Check if our direct photon signal is isolated.
(with LO view, they are isolated)

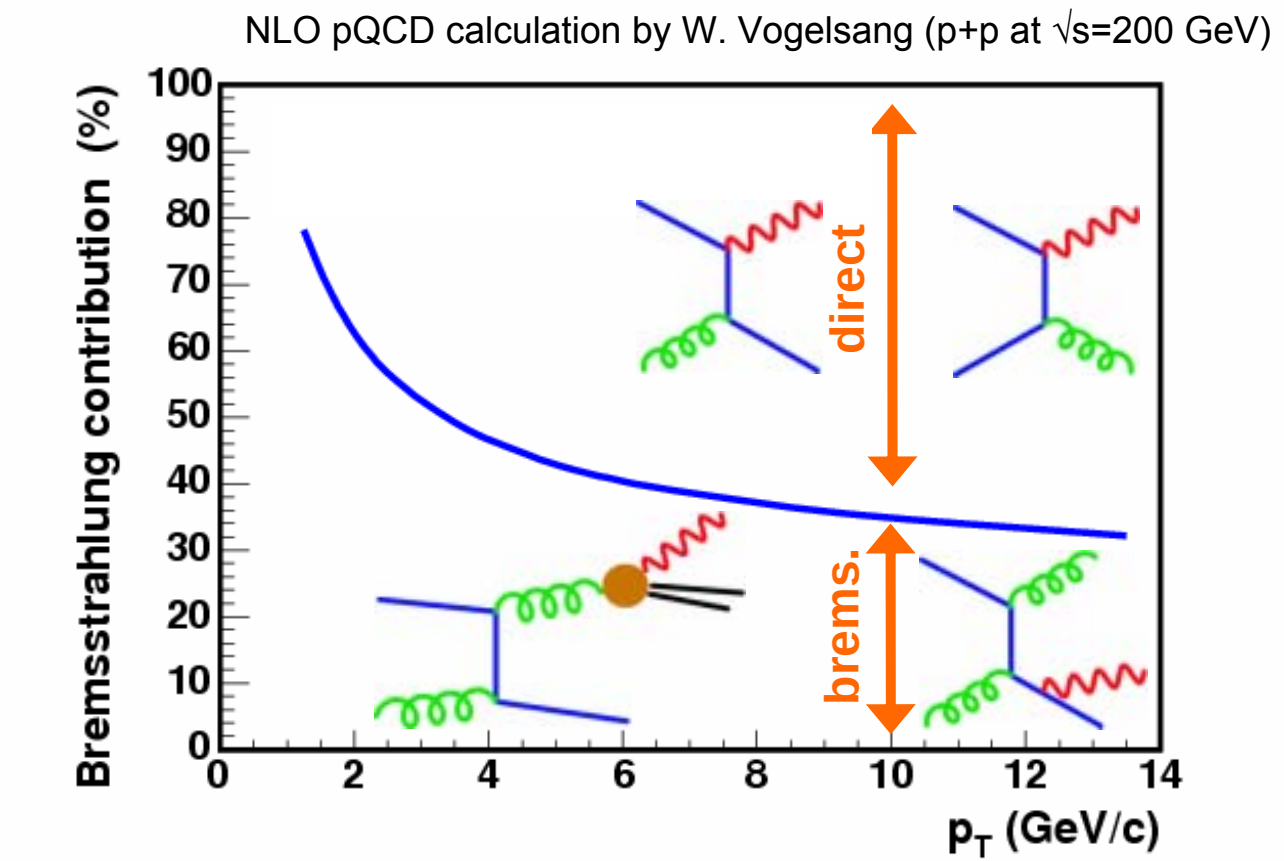


— A confirmation is done by applying the same isolation cut on photons from π^0

Isolation cut method : 2 goals

2

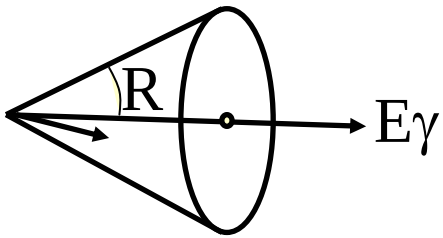
Can we extract the contribution of direct production?



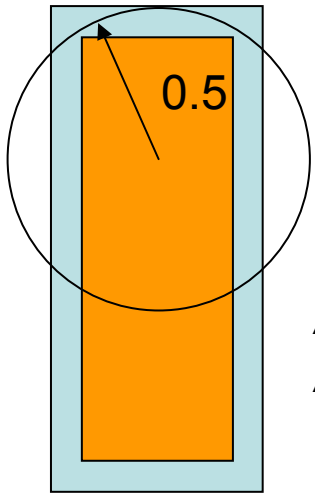
Isolation cut with PHENIX

- Starting from isolated photons

$0.1E\gamma > E_{cone}$ (R=0.5rad)



E_{cone} : photon energy
+ charged particle momentum

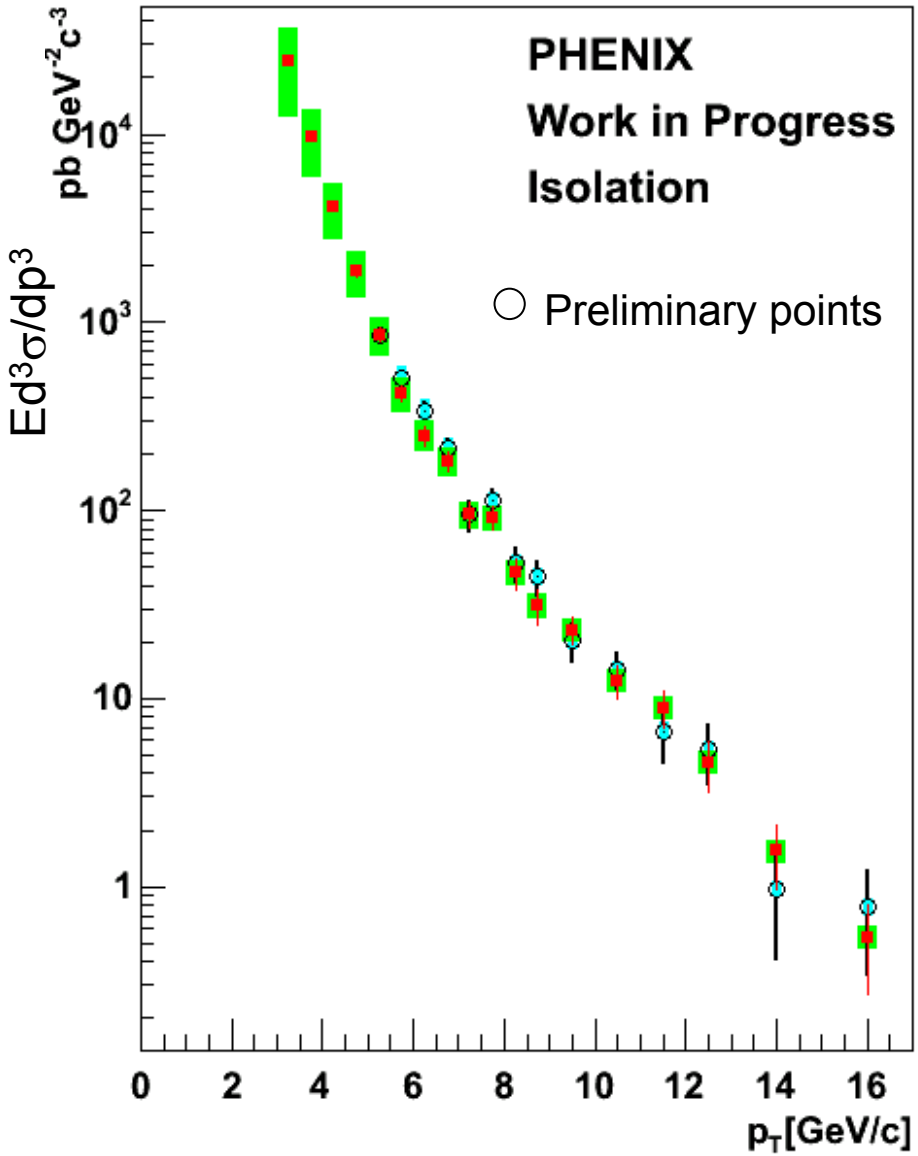


PHENIX arm
$\Delta\eta$=0.7
$\Delta\phi$=π/2

- For the estimation of hadron contribution,

"Isolated π^0 photon" is introduced
They have π^0 partner.
They pass the isolation cut when the partner energy is excluded.

Isolation cut method



Isolation cut

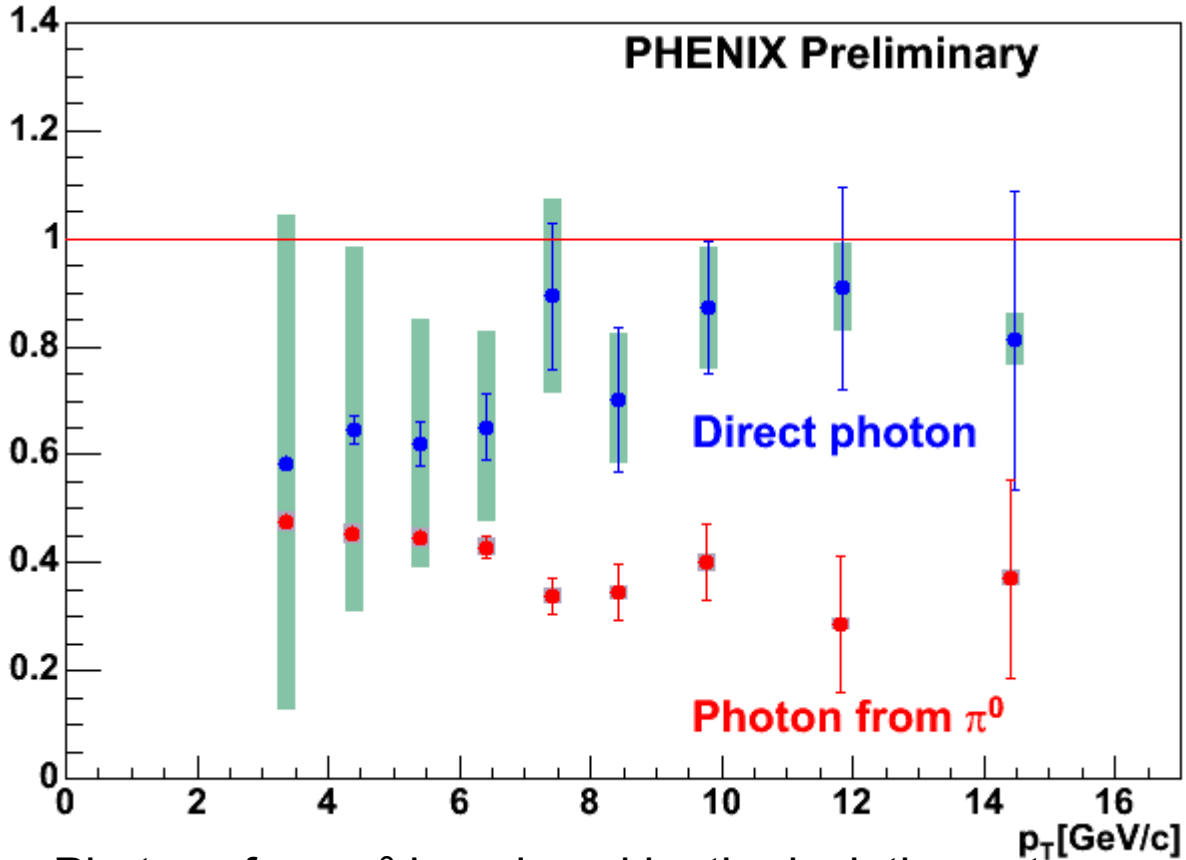
$0.1*E\gamma > E_{cone(R=0.5rad)}$

No correction for isolation cut efficiency was applied.

Ratios

1

Direct photon : isolation / subtraction
Photon from π^0 : isolated photon / all

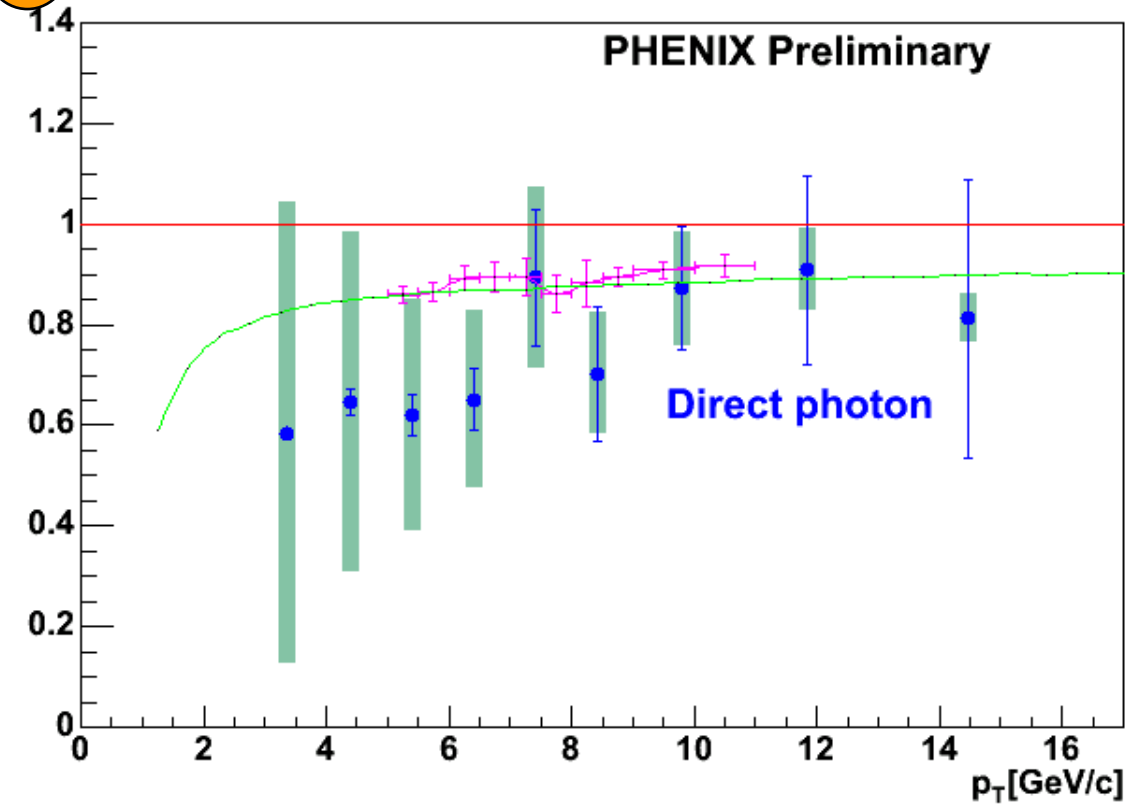


Isolation cut
$0.1*E\gamma > E_{cone(R=0.5rad}$

Photons from π^0 is reduced by the isolation cut.
Direct photons are clearly isolated at high pT region.

Iso/sub ratio with a theory calculation

2



Isolation cut

$0.1*E\gamma > E_{cone(R=0.5rad)}$

By M.Werlen,
JETPHOX
-.35<y<.35
μ=pT
BFG set2, CTEQ6M

By W.Vogelsang,
R=0.4
μ=pT, CTEQ6M

At high pT, theory predictions are consistent with the data.

Summary

We measured direct photon cross section in $\sqrt{s}$=200GeV p+p collisions.

Two methods: subtraction and isolation cut

- Subtraction method

  NLO pQCD calculation explains the data well.
  An excess in low pT region?

- Isolation cut method

  It confirmed the reduction of photons from π^0.
  Direct photon signal is isolated in high pT region.

  Level of the ratio of isolation cut method to subtraction method is same as the theory prediction.